

# Identification of tuberculosis infection and sociodemographic risk among children who come into household contact with tuberculosis in Medan, Indonesia

Fazidah A. Siregar, Lita Sri Andayani, Mhd. Makmur Sinaga

Faculty of Public Health, Universitas Sumatera Utara, Medan, Indonesia

## Abstract

Although the incidence of tuberculosis (TB) in Medan remains high, cases of TB infection among children who come into household contact with adult TB patients is still low (5.4%). The purpose of the study was to investigate the proportion of TB infection among children in the households of adult TB patients and to identify risk factors for TB infection in this population. This study was an unmatched case control study with a total of 86 study participants and a case:control ratio of 1:1. Tuberculosis skin tests and assessment with TB scoring for children were performed to determine TB infection. Data were analyzed using simple and multiple logistic regressions. The results showed positive tuberculin tests in 17 of the 43 children who had household contact with TB (39.5%). It can be concluded that the proportion of tuberculosis infection among children in households where they have contact with adult TB patients is higher than before. Therefore, it is recommended to identify children at high risk for TB and improve TB control program to minimize the risk factors.

## Introduction

Tuberculosis (TB) is a leading cause of morbidity and mortality worldwide. The World Health Organization (WHO) reported 10.4 million people were infected with tuberculosis, with 1.7 million deaths, in 2016. The majority of TB cases (75%) are found in developing countries.<sup>1</sup> Indonesia is ranked second highest for TB cases among 30 high burden countries worldwide, and the incidence of TB cases has increased annually.<sup>2</sup> North Sumatera Province, where Medan is located, is ranked fifth for TB cases in Indonesia. Medan is an endemic area with a high incidence of tuberculosis.<sup>3</sup> Currently, the number of new TB cases is increasing; however, discovery of TB cases

among children is still low.<sup>4</sup>

Persons living in the household with a tuberculosis patient have a high risk of becoming infected and developing tuberculosis, particularly if their immune defenses are impaired.<sup>5</sup> Children are a group vulnerable to becoming infected with *Mycobacterium tuberculosis*. Some research shows that the prevalence of TB infection in children living with adult TB patients was higher than in children in the general population. Certain conditions play roles in TB transmission, such as proximity to TB patients, younger age, nutritional status and living in poorly ventilated rooms.<sup>6</sup>

TB in children is both important as a health problem and also reflects the effectiveness of TB control programs. Children are typically infected with TB by adults with TB living around them. Children can also represent a source of new TB infection in adults, increasing of TB in adults in the future.<sup>3</sup> Furthermore, children are at higher risk of severe forms of tuberculosis, such as military TB and tuberculous meningitis.<sup>7</sup>

The Centers for Disease Control and Prevention recommends contact investigation to identify and test all close contacts of tuberculosis patients. However, this is rarely done in developing countries.

In the last two years, TB cases in Medan have increased and the number of children in affected households was high. However, discovery of TB cases in children is still low. This study aims to identify tuberculosis infection and sociodemographic risk among children in household contact with tuberculosis cases in Medan.

## Materials and Methods

### Study design and targeted population

This was unmatched case control study. Study conducted from May to July, 2018 on samples of cases and controls were recruited from six health facilities. The sample consisted of 43 children in households with TB cases and 43 children without household contact with TB cases. Therefore, the total number of study recruits was 86 at a case: control ratio of 1:1. All respondents were asked to give informed consent for study participation.

### Data collection procedure

Initially, a signed informed consent was asked and then the tuberculin test skin and assessment with the TB scoring system for children was performed to determine tuberculosis infection in children. The Mantoux skin test was performed by injecting 0.1 mL of 5 tuberculin units (TU) of purified protein derivative (PPD) intrader-

Correspondence: Fazidah Aguslina Siregar, Department of Epidemiology, Public Health Faculty, Universitas Sumatera Utara, University street no 21, Medan, 20155, Indonesia.

Tel : +62.61.8213221, Fax: +62.61.8213221  
E-mail: fazidah@usu.ac.id

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Ethical clearance: Before the study was conducted, human subject approval was obtained from the Universitas Sumatera Utara on March 29, 2018. The study was approved by the Research and Ethics Committee, School of Medical, Universitas Sumatera Utara (Reference code number 166/III/KPEK FK USU- RSUP HAM 2018).

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mally into the volar surface of the forearm. The result was read after 48-72 hours.<sup>8</sup> Participants were instructed to return back in 48 hours for their test result. The diameter of the induration area was measured across the forearm and recorded in millimeters of induration.

A test with an induration of at least 10 mm was considered positive. Furthermore, we assessed tuberculosis infection using TB scoring for children. Parameters were assessed using the tuberculosis scoring system for children, including history of household contact with tuberculosis patients, tuberculin skin test, nutritional status, symptoms and signs. A score of 6 or more indicated a positive tuberculosis test.<sup>9</sup>

Data was collected using a structured questionnaire. The questionnaire was involved questions about sociodemographic features such as age, sex, and education, vaccination, nutritional status, ownership of the house, type of house, crowding, house ventilation, exposure to smoke, and habitual opening of windows in the morning.

### Statistical analysis

Data was analyzed using the Statistical Package for Social Science (SPSS Release 22.0 program Inc. Chicago, Illinois, USA). Descriptive analysis of the variables was presented either as frequency distribution or proportion. The sociodemographic risk factors associated with tuberculosis infection in children with household TB contact were determined using simple and multiple logistic regressions.

### Ethical consideration

This study was carried out with approval of the study were obtained from Research and Ethics Committee, School of Medical, University of North Sumatera.

## Results

Of the total respondent, the mean age was 37.29 (9.53) years. A majority of families: had a household member with high school education (74.4%); earned income less than 2.5 million (63.8%); did not own the home where they lived (51.2%); stayed in a permanent house (65.1%); had high housing density (68.6%); habitually did not open windows in the morning (60.5%) (Table 1). The 43 children with household contacts with a person with TB were examined using the Mantoux test. Of these, 17 children (39.5%) had positive test results. This proportion was higher than previously reported by the District Health Office, which found only 5.4% of children with household contact testing positive for TB.

Among the 86 children included in this study, the mean age was 5.71 ( $\pm 3.79$ ) years. A majority of the children were male (54.7%), had the BCG vaccination (88.4%), had normal nutritional status (84.9%) and had exposure to smoking (55.8%) (Table 2).

The results of the simple logistic regression revealed several variables with p-values less than 0.25, such as: income, habitually opening window in the morning, housing density, child less than five years old, BCG vaccination and exposure to smoke (Table 3). These variables were then included in the multiple logistic regression using the enter method. This revealed three significant variables of sociodemographic risk for tuberculosis infection among children with household tuberculosis contact: age less than 5 years, habitually did not open window in the morning, and crowding (Table 4).

## Discussion

Tuberculosis infection was identified in children from 4 months to 14 years old in Medan. The proportion of tuberculosis infection was 39.5% and most cases occurred in children less than 5 years old. This study found that children aged less than 5 years have a higher risk of tuberculosis infection than those more than 5 years old. This result was consistent with findings from Guwatudde *et al.* in a study in Kampala, Uganda, that found that younger age (less than five years) was associated with increased risk of TB infection.<sup>10</sup> Young people are more susceptible to tuberculosis infection especially if they are not immunized and have poor nutritional status. Children less than 5 years old are more susceptible to health problems related to an immature immune system. Some previous

**Table 1. Sociodemographic characteristics of respondents.**

Characteristic	Frequency	Proportion (%)
Age	37.29*	9.52
Education Level		
High	64	74.4
Low	22	25.6
Income		
$\geq 2.5$ million	38	36.2
$< 2.5$ million	67	63.8
Ownership of house		
Own	42	48.8
Not own	44	51.2
House type		
Permanent	56	65.1
Semi-permanent	30	34.9
Habitual opening the window in the morning		
Yes	52	60.5
No	34	39.5
Crowding		
$\leq 2$ person/room	27	31.4
$> 2$ person/room	58	68.6

\*Mean (SD).

**Table 2. Characteristics of children.**

Characteristic	Frequency	Proportion (%)
Age	5.71*	3.79
Sex		
Male	47	39
Female	54.7	45.3
BCG immunization status		
Yes	76	88.4
No	10	11.6
Nutritional status		
Good	73	84.9
Bad	13	15.1
Exposure to indoor smoke		
Yes	48	55.8
No	38	44.2

\*Mean (SD).

studies revealed that illiteracy, proximity with the index case, exposure to smoke, household crowding, and dwelling in slum are associated with tuberculosis infection in household contacts.<sup>11,12</sup> Likewise, a study in India by Singh found tuberculosis infection in 95 of 281 contacts and determined that younger age, malnutrition, absence of BCG vaccination and exposure to smoke contributed to tuberculosis infection in children.<sup>13</sup>

Overcrowded housing conditions will influence the risk of infection in a child with contact with TB cases. Proximity has the potential to increase exposure to infectious droplet nuclei when family members infected with TB are talking, coughing and sneezing. Thus, proximity created by overcrowding contributes to tuberculosis infection among susceptible people such as children with household contact. In this study, crowding is a significant factor for tuberculosis infection in children with household contact. Children who live in crowded housing had a risk of tuberculosis that was 5.730 times greater than children who did not live in crowded housing. This finding was consistent with the findings of Gayawali *et al* (2012) in Nepal that household crowding is a significant factor for

tuberculosis among children with household contact.<sup>11</sup> Tornee *et al* (2004) in Thailand found that people living in crowded households have a risk of tuberculosis 2.63 times higher than people who did not live in crowded households.<sup>14</sup> Lienhardt *et al* (2003) in Gambia, West Africa, found that proximity to tuberculosis patients and housing density are significant factors for tuberculosis infection among children in household contact.<sup>15</sup> Baker *et al* researched New Zealand and also found that housing density was a significant factor for tuberculosis incidence.<sup>16</sup> A study by Walakandou in Kandao Hospital, Menado Indonesia, showed that population in a house (overcrowded) was associated with tuberculosis among children with household contact.<sup>17</sup> Karim *et al* (2012) in Bangladesh similarly found that crowding is a risk factor related to tuberculosis infection in children.<sup>18</sup>

The environment and sanitation of the housing play roles in disease transmission. Opening windows in the morning and during the day is necessary to maintain the quality of air and humidity in the house. Inadequate ventilation will cause the humidity in the air to increase, and this creates a good medium for pathogenic bacteria, such as the tuberculosis bacteria, to grow

and cause disease. This could increase the population being exposed to TB infection. Gustafson *et al* (2004) found that crowding and poor quality of housing are associated with tuberculosis incidence in sub-Saharan African communities.<sup>19</sup> In this study, children who live in a household that did not open windows have a risk of tuberculosis 4.452 times greater than children live in houses with opening windows. A study in Pakistan found that poor ventilation was associated with tuberculosis infection.<sup>20</sup> Lygizos *et al.*, in study in South Africa, found that opening windows and doors made a significant improvement in ventilation and air change in an hour that had an impact on reducing transmission risk of tuberculosis to 9.6%.<sup>21</sup> Likewise, Wood *et al.* (2010), in a study in South Africa, found that increased room ventilation reduced transmission risk, and thereby reduce the probability of tuberculosis infection.<sup>22</sup>

## Conclusions

This study found that the proportion of tuberculosis infection among children in household contact with an adult tuberculosis patient is high. Tuberculosis infection in

**Table 3. Factors associated with tuberculosis infection among children in household contact with tuberculosis determined using simple logistic regression.**

Variable	Children with household contact	Children without household contact	Crude OR (95% CI)	p-value
Age				
≥ 5 years	26 (60.5%)	20 (46.5%)	1.757	0.196
< 5 years	17 (39.5%)	23 (39.5%)	(1.338; 4.132)	
Income				
≥ 2,5 million	19 (44.2%)	27 (62.8%)	1.760	0.238
< 2,5 million	24 (55.9%)	16 (37.2%)	(0.618; 4.358)	
Immunization				
Yes	35 (81.4%)	41 (95.3%)	4.086	0.061
No	8 (18.6%)	2 (4.7%)	(0.933; 25.531)	
Crowding				
≤2 person/room	8 (18.6%)	19 (44.2%)	5.464	0.013
>2 person/room	35 (81.4%)	24 (55.8%)	(1.355; 7.190)	
Exposure of smoke				
Yes	29 (67.4%)	19 (44.2%)	2.617	0.032
No	14 (32.6%)	24 (55.8%)	(1.088; 6.289)	
Habitual opening of window				
Yes	19 (44.2%)	33 (76.7%)	4.168	0.003
No	24 (55.8%)	10 (23.7%)	(1.647; 10.553)	

**Table 4. Factors associated with tuberculosis infection among children in household contact with tuberculosis determined using multiple logistic regression.**

Variable	Adjusted OR (95 % CI)	p-value
Age	2.849 ( 1.000; 8.130)	0.050
Crowding	5.730 ( 1.776; 18.488)	0.003
Habitual opening of window	4.452 ( 1.652 ; 12.198)	0.004

children was influenced by younger age, crowding, and habitually not opening windows. It is therefore recommended that children who are living in households with tuberculosis patients be identified to investigate the high risk of tuberculosis in children and to design improved control strategies based on identified risk factors.

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